Effects of Insecticide Stress on Housefly Populations

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BY

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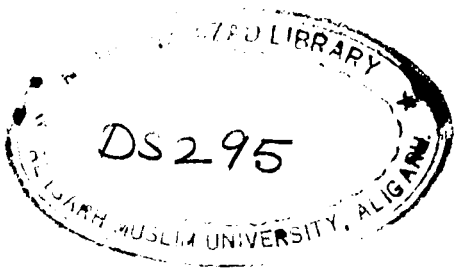

I certify that "Effects of insecticide stress on housefly population" is the original work of Mrs. Tarannum Bano and is suitable for submission for the award of the degree of Master of Philosophy of the Aligarh Muslim University, Aligarh. This work has been done by the candidate under my supervision.

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C O N T E N T S

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Introduction

Man has always been struggling against insects and despite all advancements in his knowledge and the development of sophisticated equipment and advanced technology, he has not yet succeeded in eradicating even a single species of harmful insects. One such species is *Musca domestica nebula* Fabr which has tremendous importance as a pest of public health importance.

It is a constant nuisance and a carrier of a number of diseases, such as cholera and typoid. And this is inspite of the fact that all known methods of control - mechanical, chemical and biological have been used against this insect DDT and other synthetic insecticides did provide some relief in the begining but as the species developed tolerance against these chemicals the need for alternate strategies became apparent. However no control programme can be successful unless the ecology of the species is known and we are able to identify the deleterious effects which can be produced in the metabolic process of the species through different kinds of environmental stresses. This seems to be the only way to supress its population density. Keeping

this in view the present work was an effort undertaken to determine the effects of the organophosphate compound malathion on the eggs, larvae, pupae and adults of M. d. nebulo in hope that pesticide would bring about a change in the population density of the species without contaminating the environment.

Studies on the behavioural ecology and biology of the flies are also far from being complete and it still remains to be clearly understood as to why flies resistant to one chemical, can tolerate lethal doses of one group of insecticide and not of other insecticides. The effects of environmental stress caused by the pesticides is another factor to be studied and this is the main aim of the present experiments. One has to clearly distinguish it because of their producing fewer progeny, having a longer life cycle and higher respiratory rate, the resistant flies are not so well adapted physiology to their environment as are the susceptible ones.

Review of Literature

A number of workers have studied the reproductive behaviour of *Musca domestica domestica*.

Michelson (1960) noticed that the males of *M. d. domestica* could reach sexual maturity in 18 to 27 hours after emergence and Chang (1965) observed that the minimum age of sexual maturity of male and female house flies belonging to the form *M. d. domestica* was 20 to 24 hours respectively. Ledha and his associates (1970) are however, of the opinion that males and females of *M. d. autumnalis* could mate at the age of 36 to 48 hours respectively. Such behavioural responses are however greatly affected by environmental stresses. Insecticides form one such group and these toxicants are capable of inducing significant biological differences when an insect population is exposed to them.

Metcalf (1955) believes that there is little evidence of positive correlation between factors responsible for biotic potential and specific insecticide resistance. But biological changes in an insecticide susceptible strain of house flies have been demonstrated even after one

treatment with dieldrin (Afiti & Knutson 1956). Guye et al (1957) also found considerable variations in the reproductive potential and longevity of the larvae which had been treated with malathion.

Plemental et al (1956) did not notice any significant differences in the longevity, preoviposition period, incubation period, rate of hatchability and sex ratio of a susceptible strain when compared with a highly resistant strain of M. domestica but Gagliani (1952) did find significant reduction in the larval duration of a population of house flies which had become resistant to DDT.

Hunter and his associates (1958) compared the effects of sublethal doses of DDT and diazinon on a DDT resistant and a susceptible strain of M. d. domestica and found a reduction of 34.0% in the offspring produced by the resistant strain. Such a reduction was detectable in terms of fecundity, fertility and adult survival. DDT treated females also had about 15.0% shorter life span than the normal ones.

That insecticide stress can change biological characteristics of the Indian form of house-fly, M. d. nebulo has been shown by Khan and Ahmad (1964). These

workers found that laboratory selection of adult flies for 31 generations resulted in a DDT resistance of 37 times in M. d. nebulo. Khan (1978) exposed three day old flies and also the larvae belonging to the species M. d. nebulo to DDT pressure and found that adults belonging to the resistant strain showed a longer life span but fecundity in the resistant strain was considerably less than that of the normal strain. The number of eggs laid per female in the normal and resistant strain was 401.8 and 359.4 respectively. While 81.9% of the eggs hatched in the case of the normal strain, the resistant flies produced eggs of which 81.9% were viable. The most important difference was observed in pupal weight. Thus while the weight per hundred pupae of the normal strain was 1.55 gms., it was only 1.24 gms in the case of the resistant population.

Khan (1978) further found an enhanced incubation period in the resistant population. Similarly the pre - and post - oviposition periods were lengthened in the case of the resistant strain. He also observed that the total duration of life cycle from the deposition of eggs to the emergence of adults was 11.9 and 10.3 days in the case of the resistant and the normal strains respectively.

Methods And Materials

Test Insect:-

The predominent Indian housefly *Musca domestica nebulo* Fabr was selected as the test insect mainly due to the ease with which it can be reared under laberatory condition and its public health importance. It is easily distinguishable from true *Musca domestica domestica* by its smaller size, narrower thorax bands and lighter colouration of the abdomen.

Rearing Techniques:-

House flies have been reared on various media. Hutchison (1916) recommended horse manure for rearing them while Hoskenyas (1931) suggested that horse manure mixed with hog manure was a better rearing medium. Musham (1944) obtained best breeding conditions with Cowdung and Busvine (1953) reared house flies on the faeces of the monkeys.

Hofes (1948) successfully reared *M. d. domestica* on cotton wool soaked in milk diluted with water in a ratio of 3:1. The present author used the same technique with slight modifications. Milk was diluted with equal

quantity of water and cotton wool pads were soaked in it. Adult flies were kept in sleeve cages and were fed on these pads. A few cubes of cane sugar were also provided in each cage. Oviposition readily occurred on such pads, which were seeded in culture jars containing food prepared in the same manner. Moisture greatly effected the development of earlier instars and 70 to 80 percent moisture content was found to be highly favourable for larval development. However, when the larvae were mature and were about to pupate some dry cotton wool was added to the jars in order to faseilitate pupation and also to prevent the larvae from getting out of the jars. Newly formed pupae were removed in petridishes and were kept in sleeve cages for the flies to emerge. It was found that in cases where sugar cubes were not provided, the flies remained rather unhealthy and inactive.

The rearing cages were constructed of wire frames covered over with loosely fitted cloth sleeves. The same type of cages, but only four inches square in size were used for rearing individual pairs.

Cellophane cages about four inches in height and with card board tops were used for keeping the treated flies. Each cage was used only once in order to avoid any contamination.

The larvae were cultured in glass jars about 8 x4 inches in size and were covered over by thick cloth pieces in order to check the larvae from escaping.

Method of Testing Insecticide Solutions:-

Four day old flies were treated individually with desired solutions of the insecticide in acetone by sweeping them in a test tube. The flies were anaesthetised with a slight dose of carbon dioxide. Each fly thus anaesthetised was held by its wings with a fine forceps and was brought to the tip of the needle. A measured drop of the insecticide solution was placed on the dorsum of each fly. The size of the drop was controlled by means of a screw - gauge fitted against the head of the syring. The flies were sexed during testing and those belonging to the same sex were kept in seperate cage. Mortality counts were made after twenty four hours of the treatment.

Malathion stress on the pre-adult and adult stages of *M.d. nebula*

When an organism is exposed to such a factor which could pressurise its normal homeokinetic balance, it is said to be stressed. Such stressed organisms suffer from physiological disorders which may even adversely affect the growth and reproduction and in the long run, the very survival of the species. Among the various types of stresses, those caused by chemical pesticides have been studied in some details.

Speich (1946) reported that continuous exposure of *M.d. domestica* to DDT stress increased its tolerance to the insecticide and affected control operations. The degree of stress was however dependent not only on the concentration of the pesticide but also on its chemical composition. Thus satisfactory control of house flies could be obtained by Yasutomi *et al* (1962) by spraying them with 5.0% fenchlorphos or a mixture of 3.0% trichlorphon.

Of the 119 compunds screened by L. Brecque *et al* (1967) for their insecticideal efficiency against DDT resistant and susceptible strains of *M. domestica*,

Bayer 30554 formothion and Stauffer - N - 3054 were found to be equally effective. Bailey et al (1968) however observed that dichlorphos was slightly more toxic to the flies than trichlorfon.

Sharma and Kalra (1962) compared certain organophosphate insecticides against M.d. nebulo and noticed that fenthion was the most persistant insecticide and when applied at a rate of 200 mg/sq-ft caused 85.0% mortality of the flies for 60 days. Bailey et al (1970) observed that dimethoate, fenthion, formothion, naled, ronnel and trichlorfon provided about 75.0% control of the M.d. domestica for eighteen days.

Barber et al.(1948) studied the biological effects of insecticide stress and observed higher pupal weight and lower percentage of emergence in a population of house flies resistant to DDT. Piemental et al. (1951) found longer larval duration in a DDT resistant strain of M.d. domestica.

Several other biological characters such as fecundity, fertility of the eggs and adult weight have also been found to be affected due to insecticide pressure. Grats (1966) observed an increase in the life span and the fertility of a population of flies resistant to dieldrin, though Rahman (1965) observed that the oviposition period and

the adult longevity of the M.d. nebulo were adversely affected. When the species was subjected to dieldrin selection pressure and then Khan and Shukla (1978) observed an increase in the pre-oviposition and post-oviposition periods in the case of M.d. nebulo. In 1976 Suknova et al. showed that a strain of M. domestica highly resistant to trichlorfon exhibited a decrease in fertility, significantly higher death rate in the pre-adult stages during metamorphosis and also a high proportion (upto 18%) of deformed pupae.

Lu and his associates (1978) studied the effects of aldrin, methoxychlor and parathion on the life span of male Pharmia regina and observed a shortening of 4.34, 6.87 and 21.19 days in the life span of the flies treated with aldrin, methoxychlor and parathion respectively.

No such studies have however been made concerning the effects of malathion stress on the Indian form of housefly, M.d. nebulo and therefore, it was considered desirable to study the effects of the stress of sublethal doses of malathion upon M.d. nebulo.

The insects used during the present studies were obtained from a laboratory colony, originally developed from field collected flies in Aligarh. These were kept

in sleeve - cages measuring 8"x8"x8" in size and were fed on cotton wool soaked in diluted buffalo milk at a temperature 28±2°C and 70 to 80% relative humidity. Eggs laid in petridishes were embeded in glass jars containing layers of cotton wool soaked in diluted milk. Some dry cotton was added to the jars on the fifth day of the embedding of the eggs for pupation. Pupae were then sorted out and were kept in cages (8"x8"x8" in size) for emergence.

Four day old flies were treated topically with 0.0156% concentration of malathion in acetone. The flies were sexed during testing and those belonging to a particular sex were kept in seperate cellophane cages for twenty four hours when mortality counts were made.

From among the survivors, four pairs were kept in one cage (4"x4"x4" in size), three single pairs were also kept in seperate cages measuring 4"x4"x4" in size. Milk soaked in cotton wool in small petridishes (1.25" in diameter) was supplied as food which was changed after every 24 hours.

The eggs thus obtained were counted and kept seperately on moist black cloth for 24 hours to observe their hatchability

Some eggs obtained from mass pairs and single pairs were embeded seperately in jars to record larval and pupal

Table - I

Effects of malation stress on the bionomics of M.d. nebulo

S.No.	PAIRING Mass/Single	% Hatching of eggs	Larval duration in days	Pupal duration in days	Pre-oviposition period in days	Oviposition period in days	Post-oviposition period in days	Longevity of adult in days	
								Male	Female
1.	Mass rearing (Normal)	100.0	5.0	6.0	6.0	10.0	3.0	12.0	19.0
2.	Mass rearing (Treated)	97.0	6.0	5.0	6.0	12.0	3.0	9.0	21.0
	Single pair rearing (Normal)								
	Pair I	95.0	5.0	6.0	5.0	11.0	4.0	11.0	20.0
	II	98.0	6.0	7.0	6.0	9.0	5.0	12.0	20.0
	III	100.0	5.0	5.0	6.0	9.0	3.0	13.0	18.0
3.	Mean	97.66	5.33	6.0	5.66	9.66	4.0	12.0	19.33
	Single pair rearing (Treated)								
	Pair I	100.0	6.0	5.0	5.0	9.0	5.0	10.0	20.0
	II	100.0	6.0	7.0	4.0	12.0	4.0	11.0	20.0
	III	84.4	6.0	5.0	7.0	10.0	5.0	10.0	22.0
4.	Mean	94.66	6.0	5.66	5.33	10.33	4.66	10.33	20.66

Table - II

Summarised results on the Effects of malathion on the bionomics of M.d. nebulo

S.No.	PAIRING Mass/Single	Strain	% Hatching of eggs	Larval duration in days	Pupal duration in days	Pre-ovi-position period in days	Ovipo-sition period in days	Post-Ovipo-sition period in days	Longevity of adult in day	
									Male	Female
1.	MASS	NORMAL	100.0	5.0	6.0	6.0	10.0	3.0	12.0	19.0
		TREATED	97.0	6.0	5.0	6.0	12.0	3.0	9.0	21.0
2.	SINGLE	NORMAL	97.66	5.33	6.0	5.66	9.66	4.0	12.0	19.33
		TREATED	94.66	6.0	5.66	5.33	10.33	4.66	10.33	20.66

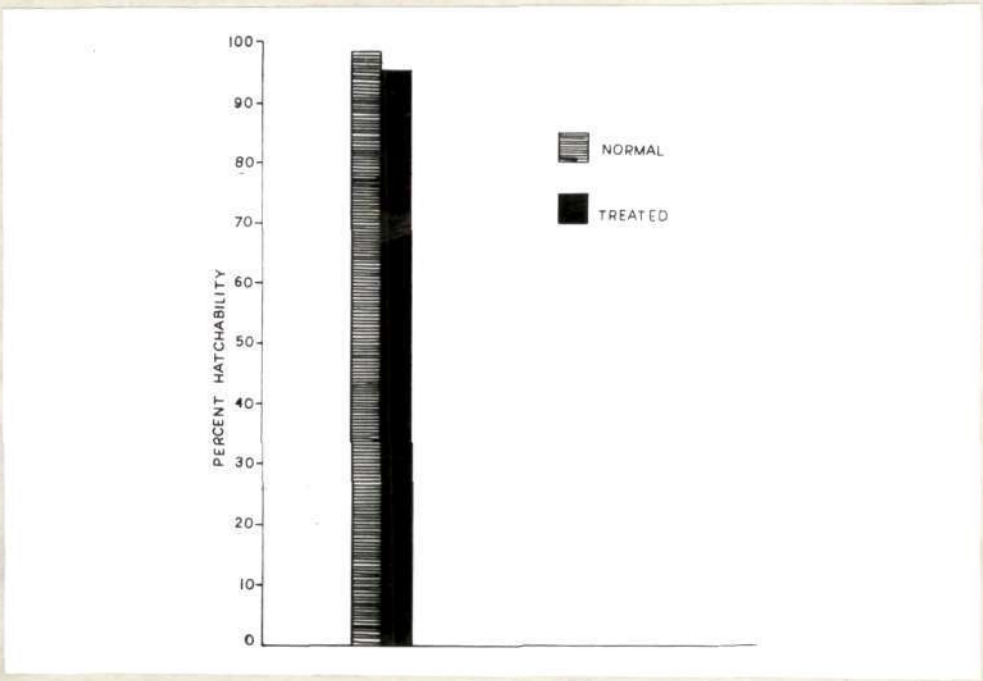

Figure - I. Effect of malathion on the hatchability of eggs of Musca domestica nebulo.

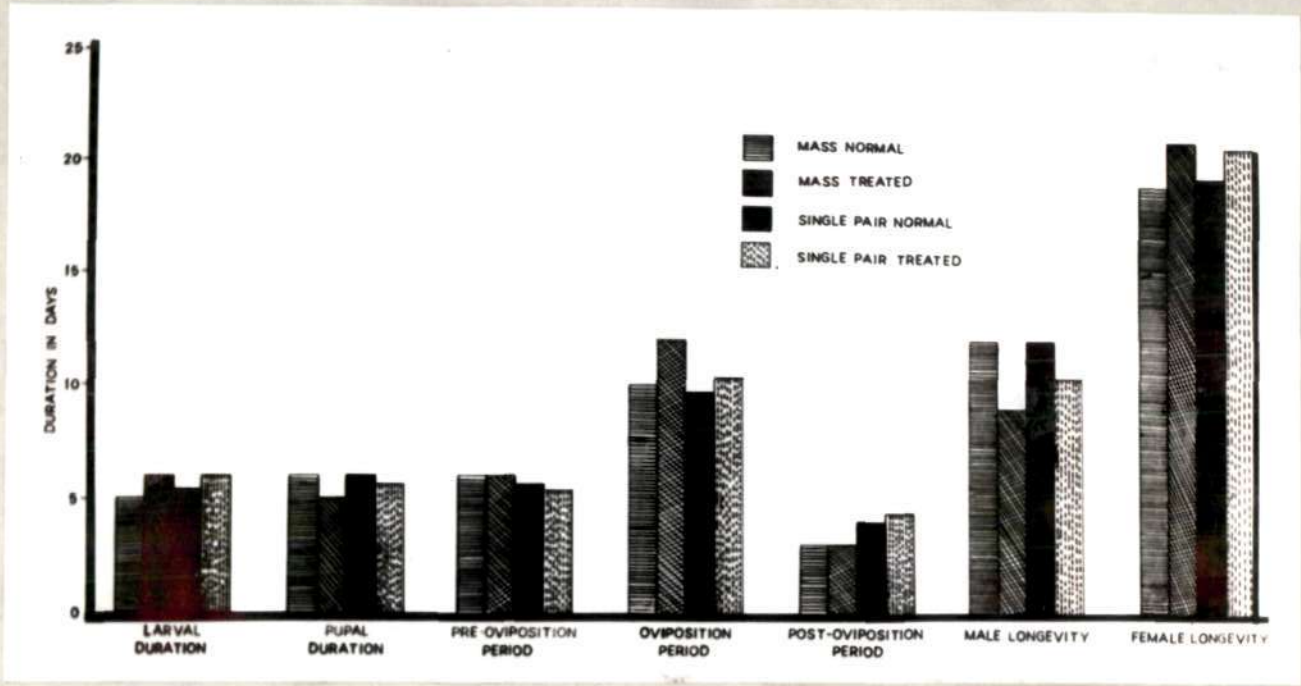

Figure - II. Effect of malathion on the pre-adult and adult stages of Musca domestica nebulo.

duration. The pupae obtained were sorted out and were kept in petridishes to observe percentemergence. Freshly emerged flies were also kept in single pairs as well as in mass pairs to observe the pre-oviposition, oviposition and post-oviposition periods. Longevity of adult flies was also recorded.

During the present work it was found that in mass pairing the larval duration was prolonged by one day, where as the pupal duration was reduced by one day as compared to the normal flies. The pre-oviposition and post-oviposition periods remained unaffected, but oviposition period was found which increased from 10 to 12 days. It was also observed that the longevity of both the males as well as the females was affected. In the case of the males it was reduced by three days where as the longevity of the females showed an ascending trend and increased by two days (Tables-I and II)

Comparison between treated flies kept in masses and in single pairs revealed that while most of the factors studied remained unaffected the oviposition period was reduced from 12.0 to 10.33 days. (Figure-I)

No significant difference could be obtained in the hatchability of eggs obtained from the treated and normal flies, the percentage hatching being 95.63% to 98.83% respectively (Figure-I)

Conclusions

1. When M.d. nebulo was subjected to sublethal doses of malathion and kept in masses, the larval duration increased by one day in the case of the treated population as compared to the normal flies. The pupal duration was however reduced by one day.

2. A prolongation of 2 days was observed in the oviposition period of the treated flies, while the pre and post-oviposition periods remained unaffected, when the flies were kept in masses.

3. Longevity of both the sexes was affected slightly when kept in masses. The life span of male flies was reduced by 3 days while that of the females was prolonged by 2 days in the case of the treated population.

4. The oviposition period got reduced from 12.0 to 10.33 days in the case of single pair crosses.

5. No significant results could be obtained in the hatchability of the eggs of the treated and the normal flies The percentage of hatching was 95.63 in treated and 98.83 in the normal population.

Summary

From his very begining on this earth, man is facing the onslaught of noxious pest species which are responsible for huge economic losses as they consume up the crop grown by man and spread diseases among human and animal populations. Musca domestica nebulo is one such species which is abondantly found in India and is a carrier of a number of disease pathogens. All this economic importance of the flies has forced us to develop techniques to manage its population below economic threshold.

Though some success in the control of M.d. nebulo has been achieved with the use of the synthetic organo-chlorine insecticide DDT, we have not yet been able to solve this problem. Often the haphazard use of chemical pesticides has resulted in unwanted consequences and the species has developed tolerance to such chemicals. In view of this situation it was considered desirable to determine the effects of the stress caused by sublethal doses of malathion on the bionomics of M.d. nebulo.

The flies used during the present tests were reared on diluted buffalo milk soaked in cotton wool pads at a temperature 28±2°C and 70-80% relative humidity. Sleeve - cages constructed of wire-frames and covered over by meshed cloth were used and the eggs obtained were embeded in cotton pads in jars 8"x4" in size. Some dry cotton wool was added to each jar on the fifth day of the embedding of the eggs in order to facilitate pupation. The pupae so obtained were kept in cages for the flies to emerge.

Four day old flies were treated topically with 0.0156% malathion in acetone. The flies were sexed during treatment and were kept in seperate cellophane cages, where mortality counts were made after 24 hours. The surviving flies were kept in masses of 4 pairs in one cage and single pair in three seperate cages. Food was supplied in small petridishes and was changed after every twenty four hours.

Observations were recorded on the hatchability, larval and pupal durations, pre-oviposition, oviposition and post-oviposition periods as also on the longevity of the treated and normal flies.

Percent hatchability was observed by counting the number of unhatched eggs. No significant affect

could however be observed on the hatchability of the eggs. The larval duration in the case of the treated flies was prolonged by one day while a shortening of one day was recorded in the case of the pupal duration.

To investigate the effect of sublethal doses of malathion on the pre-oviposition, oviposition and post-oviposition period and on the longevity of the flies 4 pairs obtained from the normal and treated colonies were also kept in small cages measuring 4"x4"x4" in size. Single pairs of normal and treated flies were also kept in seperate cages to compare the effects of mass pairing with that of single pairing. The results obtained showed that while the pre and post-oviposition periods remained unaffected in cases where mass treatments were made, the oviposition period was prolonged from 10 to 12 days from normal to treated flies.

Thus a longevity of 12 days of the normal males was reduced to 9 days in the case of the treated males. However the longevity of 19 days in normal females was prolonged to 21 days in the case of the treated females.

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References Cited

Afiti, S.E.D. and Knutson, H.	1956	: Reproductive potential longevity and weight of houseflies which survived on insecticide treatment Jour.Econ.Ent. 49 : 310-313.
Bailey, D.L., La Brecque, G.C., Meifert, D.W. and Bishop, P.M.	1968	: Insecticide in dry sugar baits against two strains of houseflies. Jour, Econ.Ent. 61(3) : 743-747.
Bailey, D.L., La Brecque G.C. and White field, T.I.	1970	: Insecticides in dry sugar baits for control of houseflies in Florida dairy barns Jour.Econ.Ent. 63(6) : 2000-2001.
Chang, S.C.	1965	: Chemosterilisation and mating behaviour of male houseflies. Jour.Econ.Ent. 58(4) : 669-672.
Gagliani, M.	1952	: Durata dil cielo larvale in ceppi de M. domestica sensibili a resistant at DDT Boll, Della Societa Italiana Di Biologia experimental 26(3) : 326-328.
Grats, N.G.	1966	: The effect of the development of dieldrin resistance on the biotic potentials of houseflies in Liberia. Acta.Trop. 23(8) : 108.
Hunter, P.E.L.K. Cukkamp and A.M. Kolkaila	1958	: Reproduction in DDT and Diazinon treated houseflies Jour.Econ.Ent. 51 : 577-582.
Khan, N.H. and Ahmad, D.	1964	: Inheritance of BHC resistance in house fly Musca domestica nebulo Fabr. Jap.JournGenetics. 38(5-6) : 367-373.

Khan, N.H. and Shukla, R.N.	1973	:	Effects of propoxus bait on the bionomics of M. d. nebulo. Raj. J. of Pesticides December Vol. 5(2) :
La Brecque, G.C., Wilson, H.G. Brady, U.E. and Gahan, J.B.	1967	:	Screening tests of contact sprays for control of adult houseflies. Jour.Econ.Ent. 60(3) 760-762.
Lodha, K.R., Treece, R.E. and Kouts, F.R.	1970	:	Studies on the mating behaviour of the face fly. Jour.Econ.Ent. 63(1) : 207-212.
Metcalf, R.L.	1955	:	Organic Insecticides. Willay (Inter sciences) New York 392 pp.
Michelson, A.	1960	:	Experiments on the period of maturation of the male house-fly Musca domestica L. Oikos 11(II) : 250-264.
Onye, M.T. and H. Knutson	1957	:	Reproductive potential longevity and weight of houseflies following treatment of larvae with malathion. Jour.Econ.Ent. 50 : 490-493.
Piemental, D. Dewey, J.E. and Schwardt, H.R.	1951	:	An increase in the duration of life cycle of DDT resistant strain of housefly. Jour.Econ.Ent. 44 : 477-481.
Rahman, S.J.	1965	:	Bionomics of dieldrin resistant normal strains of Indian housefly, Musca domestica nebulo Fabr. Bull.Indian Soc-Malar. Common Dis. 2(2) : 150-153.
Speich, H.	1946	:	Insecticide resistance in Arthropods WHO Monograph. Series No. 38 : 104.
Sharma, M.I.D. and Kalra, R.L.	1962	:	A note on the relative toxicity of organophosphorous insecticides against houseflies. Ind.Jour.Malar. 16(1) : 25-30.

Suknova, M.N., Gvozdeva, I.V., Tetero Vakaya, T.O. and Kiryukhantsera, V.N. 1976 : The fertility of houseflies (Musca domestica L.) highly resistant of chlorphos. Meditrinskaya, Parasitologiyal i parazitarnye Bolezni 45(1) : 52-56.

Yasutomi, K. and others 1962 : Control tests of diazinon resistant houseflies. (In Japanese). Jap.J.San.Zool. 12(4) : 283-288.

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